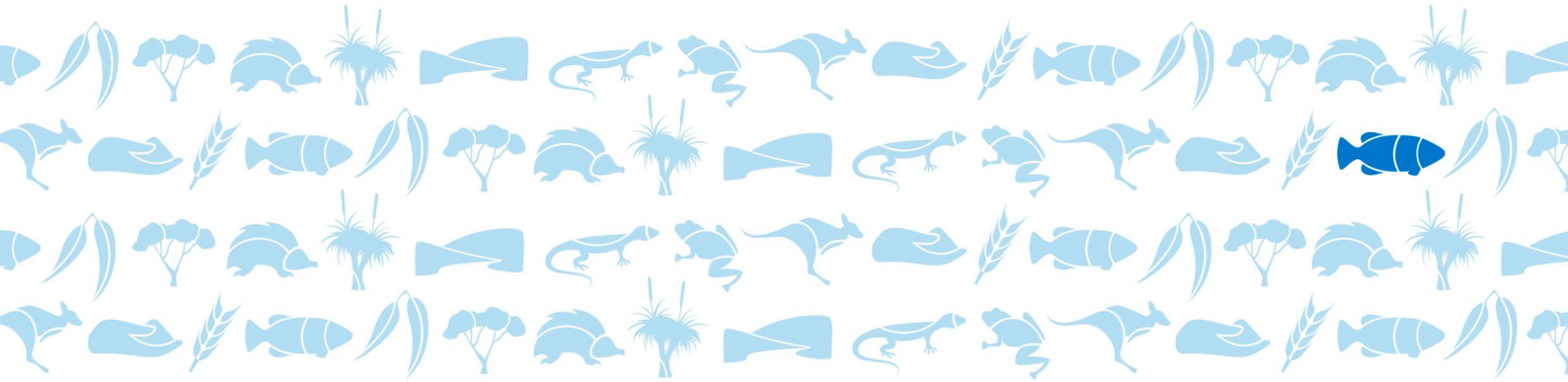
South Australian Murray-Darling Basin Natural Resources Management Board

Angas Bremer Water Management Committee Inc

AQUIFER STORAGE & RECOVERY – SOURCE WATER RISK ASSESSMENT



Angas Bremer Land and Water Management Plan

January 2009

1. Background

As part of ongoing development of the Angas Bremer Land and Water Management Plan, the Angas Bremer Water Management Committee Inc (ABWMC) sought funding from the South Australian Murray-Darling Basin Natural Resource Management Board to analyse water quality from the Angas and Bremer rivers and Lake Alexandrina which are commonly and increasing used for the purpose of Aquifer Storage and Recovery (ASR).

The aim of the project was to:

- identify whether or not there were contaminates present in the surface water resources used for ASR
- determine suitability of the surface water for ASR
- compare the values with the *Australian Drinking Water Guidelines* (ASWG) and the *Environmental Protection Water (Quality Policy) Guidelines EP(WQ)P).*
- identify pre-treatment requirements if necessary.

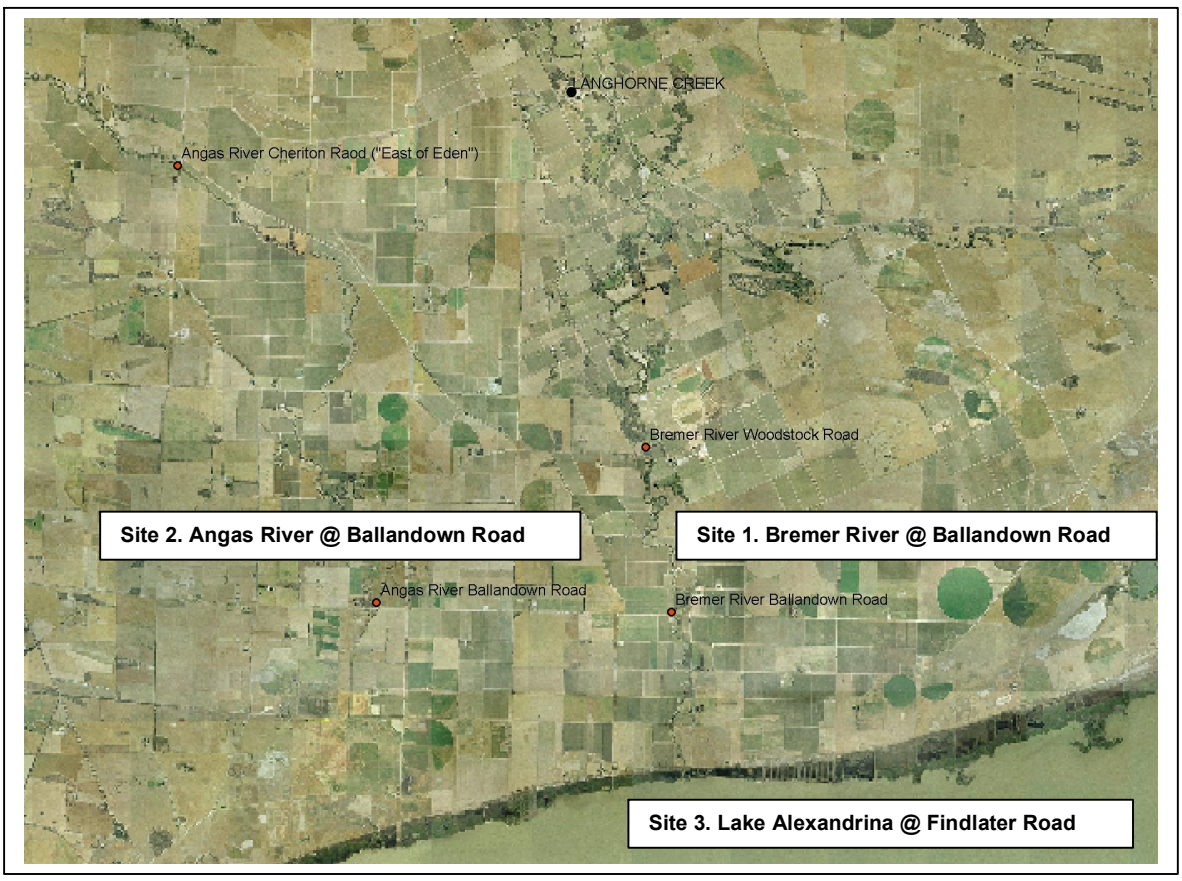
2. Methodology

Water samples were collected by the Australian Water Quality Centre on the 30 July 2007 from the following sites:

- Bremer River @ Ballandown Road
- Angas River @ Ballandown Road
- Lake Alexandrina @ Findlater Path

On the 22nd of September 2008 this process was repeated with the addition of a sample of water taken from a well used for Aquifer Storage and Recovery in Langhorne Creek. This ASR well had been used to pump water piped from Lake Alexandrina into the confined aquifer. Also, due to the fact that the Bremer River did not reach Lake Alexandrina this year, the Bremer sample was taken from the point where the river crosses Wanstead Road, north of Langhorne Creek.

Figure 1. Location of 2007 sampling sites



Samples were analysed by the Australian Water Quality Centre. Results were compared with the *Australian Drinking Water Guidelines (*also adopted by the EPA in the *EP(WQ)P)* and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC).*
In 2008 as well as bacteriology and inorganic chemistry, the water samples were also analysed for the presence of organic substances including Organochlorine Pesticides, Organophosphorous and Triazine Pesticides and volatile Organic compounds.

3. Results

Table 1.
Aquifer Storage and Recovery Source Water Analysis 22 Sept 2008 and 30 July 2007

Chemical Analyses of source water : Bremer River @ Wanstead Road (2008), Bremer River @ Ballandown Road (2007), Angas River @ Ballandown Road, Lake Alexandrina @ Findlater Road, Langhorne Creek Recharge Bore

Sample point	Bremer River	Bremer River	Angas River	Angas River	Lake Alexandrina	Lake Alexandrina	Langhorne Creek Recharge Bore	[1]Australian Drinking Water Guideline Values
Analyte	**22/09/2008**	**30/07/2007**	**22/09/2008**	**30/07/2007**	**22/09/2008**	**30/07/2007**	**22/09/2008**	
pH	7.7	7.4	7.7	8	8	8.3	7.8	6.5-8.5*
Temperature (C)								no set value
TDS by EC (mg/L)	1800	1200	1400	1000	2500	1100	1500	500*
EC (uS/cm)	3190	2100	2540	1810	4500	2050	2630	
Tubidity (NTU)	14	2	2.7	6.1	34	58	0.49	5*
Calcium (mg/L)	95.6	66.1	119	77.9	69.6	45.8	67.9	
Magnesium (mg/L)	67.7	46.5	57.8	41.1	96.1	44.1	56.9	
Sodium (mg/L)	455	294	311	235	748	307	375	
Bicarbonate (mg/L)	211	163	259	190	256	182	272	
Chloride (mg/L)	1310	510	1080	451	1960	507	1110	250*
Sulphate	239	139	93.6	79.8	209	98.1	88.2	500
Ammonia as N (mg/L)	0.036	0.02	0.018	0.92	0.008	0.006	0.66	0.61
Nitrate as N (mg/L)	0.103		0.034		0.003		0.057	11.29
Nitrite as N (mg/L)	0.006		<0.005		<0.005		0.009	0.95
Phosphorus Total as P (mg/L)	0.065	0.057	0.031	0.039	0.156 0.156	0.062	0.037	0.05[1] 0.8-12[2]
Nitate + Nitrite as N (mg/L)	0.109		0.039		0.008		0.066	12.24
Arsenic (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.007
Boron (mg/L)	0.228	0.138	0.1	0.084	0.329	0.15	0.203	0.3*
Cadmium (mg/L)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.002
Chronium (mg/L)	0.003	<0.006	<0.003	0.007	<0.003	0.01	<0.003	0.05
Iron (mg/L)	0.894	0.128	0.192	0.395	1.217	3.25	0.522	0.3
Lead (mg/L)	0.0009	<0.0005	<0.0005	<0.0005	0.0011	0.0017	<0.0005	0.01
Manganese (mg/L)	0.1312	0.02	0.0079	0.006	0.0695	0.039	1.236	0.1
Zinc (mg/L)	0.032	0.017	<0.003	<0.003	0.019	0.004	0.082	3
Faecal Coliforms (/100mL)	1200	28	130	57	130	38	0	0
Coliforms (/100mL)	2800	2600	650	3300	2500	490	0	0
Trihalomethans (mg/L)								0.25

LEGEND for Table 1

[1]National Health and Medical Reasearch Council & Agriculture and Resource Management Council of Australia and New Zealand (1996) 'Australian Drinking Water Guidelines - 6'

[2] National Water Quality Management Strategy, Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000-4, ANZECC and ARMCANZ

denotes levels or amounts of the substances, materials or characteristics that exceed those in native water

* denotes aesthetic guideline values - the unmarked values are health-related guideline values.

Red denotes values that exceed the guideline values as documented in the Australian Drinking Water Guidelines.

Blue denotes values that exceed guideline values as documented in the Australian and New Zealand Guidelines for Fresh and Marine Water Qualty 2000. (Page 4.2-13)

4. Conclusions and Recommendations[1]

Source Water

Analysis of results show the source water from the Angas and Bremer Rivers and Lake Alexandrina in 2008 generally fell within the values specified by the ADWG with the exception of:

- Total Dissolved Solids (TDS by EC (mg/L)),
- Turbidity for the Angas River and Lake Alexandrina
- Chloride (Cl)
- Ammonia for the Angas River
- Phosphorous for the Bremer River and Lake Alexandrina
- Iron (Fe) for Lake Alexandrina
- Faecal Coliforms, and
- Coliforms

The only tested for organic substance found in the samples was a small amount of Dibromochloromethane found in the Angas River (2 µg/L) sample.

Comparison with 2007 results - While both Ammonia and Iron levels in the water sample from the Angas River were above the guidelines in 2007, they were acceptable in 2008.

Aquifer Storage and Recovery Well

The water collected from the ASR bore fell below the guidelines set by the ADWG with the exception of:

- Total Dissolved Solids (TDS by EC (mg/L)
- Chloride (Cl)
- Ammonia
- Arsenic
- Iron (Fe) and
- Manganese (Mn)

A trace of Dibromochloromethane was found in the ASR well (1µg/L).

Comparison with source water (Lake Alexandrina) – A few of the analytes were in greater concentrations in the well sample than the source water from the lake, including Ammonia, Nitrate and Nitrite, Arsenic, Manganese and Zinc. This suggests that they were already present in the ground water rather than being added with the lake water. Further ground water sampling at other sites would confirm if this is the case.

The analytes in lower concentrations in the well sample than the lake sample include Total Dissolved Solids (although it was still above the levels set in the ADWG guidelines in the ASR well sample), turbidity, Phosphorous, Boron, and Iron (also above guideline levels in the ASR sample). The most interesting difference was the fact that the high coliform and faecal coliform concentrations in the lake water were not represented in the ASR well sample, where no trace was found. This suggests that the aquifer is able to attenuate some of the contaminants from the source water.

Further information and recommendations

Total Dissolved Solids - Based on taste, the TDS concentration relates to poor drinking water quality. The TDS concentration of all sources of water is almost double that of the ADWG.

Turbidity - The measured value for turbidity indicates the density of suspended solids in the water to be drained. The ADWG value for turbidity is an aesthetic rather than health base value. For the purpose of ASR the drainage of turbid water into the well may affect the well efficiency by causing clogging. Clogging will permanently impair the well's discharge efficiency and/or the ability to yield

[1] Zulfic, D & Sampson, L. *Water Quality Parameters that Exceed Guidelines and Recommended Management.* DWLBC.

efficiently. Therefore it is recommended that the drainage water is filtered (max 100 micron) to remove suspended matter in order to protect the well from clogging.

Chloride - The chloride concentration is greater than the LTV for sensitive to some moderately tolerant crops in accordance with the ANZECC guidelines. High chloride concentrations in irrigation waters can cause foliar injury and cause corrosion to irrigation equipment. The concentration is also greater than the aesthetic value for drinking water (250 mg/L) under the ADWG.

Ammonia - There is no health-based guideline values set for ammonia. The ADWG value is based on aesthetic considerations (the corrosion of copper pipes and fittings). Ammonium (ammonia ion) is highly soluble but strongly sorbs to soil and sediment surfaces and is transformed by obligately aerobic bacteria to nitrite and on to nitrate under oxic conditions. Therefore, ammonia may attenuate in the aquifer depending on conditions. Consequently, pre-treatment is not required but it is recommended that the aquifer is sampled down gradient of injection locations. High concentrations of Ammonia can cause corrosion in copper pipes and cause staining.

Phosphorous - The phosphorous concentration in the Bremer River and Lake Alexandrina is above the long-term trigger value (LTV) and lies within the short-term trigger value (STV) range. As phosphorous aids in the growth of organisms, the LTV has been set to prevent algal growth in irrigation water. It has been demonstrated that the concentration of phosphorous will attenuate in the aquifer. Due to this fact pre-treatment is not required, however it is recommended that future aquifer sampling is conducted down gradient of the injection locations. The purpose of this is test that the phosphorous concentrations do not exceed the LTV and the aquifer has the capacity to effectively attenuate the phosphorous concentrations.

Iron - The iron concentration in both the Angas River and Lake Alexandrina is greater than the LTV (0.2mg/L), however much lower than the STV (10mg/L) in relation to the ANZECC. The LTV is based on the maximum concentration of iron in the irrigation water that can be tolerated assuming 100 years of use. These values have been set to minimise subsurface soil contamination and direct contamination to crops. The iron concentration is also greater than the ADWG (0.3mg/L). This is an aesthetic value based on taste. High iron concentrations can cause taste, staining and blockages in irrigation equipment.

Boron - may be an essential trace element for humans and based on an acceptable range of oral intake (AROI), a concentration of up to 4 mg/L in water would not pose a human health risk. The level in the Lake Alexandrina sample is slightly above the Australian Drinking Water Guidelines but below 4 mg/L.

Faecal coliforms and coliforms – Injected water should be disinfected to remove all faecal coliforms and coliforms. Disinfection can be achieved by chlorination or ultraviolet disinfection. If chlorination is the chosen method the disinfection byproducts 'Trihalomethanes (THMs)' must be included in the suite of water quality parameters for monitoring. The concentration level of THMs must not exceed 0.25mg/L under the Australian Drinking Water Guidelines.

Dibromochloromethane – This is one of the Trihalomethane byproducts formed when chlorine interacts with naturally occurring organic substances in water such as decaying plant and animal matter and algae. Excessive exposure through inhalation or skin contact can have adverse effects on human health, especially on the central nervous system. Australian Dinking Water guidelines allow a total THM concentration of 250 µg/L and state that levels may occasionally fluctuate up to 1000 µg/L without significant health risk. The levels found in these water samples were therefore well below the levels stipulated in the guidelines and should not be a concern. It is unclear where the chlorine in the Angas River and ASR bore sample might have originated.